

ZOOLOGY.—*Taxonomy of the copepod genera Pherma and Pestifer*. R. U. GOODING, University of Washington. (Communicated by Fenner A. Chace, Jr.)

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In 1923, C. B. Wilson instituted the genus *Pherma* for a new species of copepod, *P. curticaudatum*, specimens of which had been collected from an annelid off the coast of Lower California. He placed it in the Clausiidae, a family containing a number of other annelid associates. However, in revising this group, M. S. Wilson and Illg (1955: 135) considered that "it would be impossible to assign (*Pherma*) to any family, since C. B. Wilson omitted a description of the oral appendages."

Twenty-one years later, in a paper published posthumously, C. B. Wilson (1944) described another new genus, *Pestifer* (with genotype *P. agilis* also from an annelid but in the Gulf of Mexico), which he referred this time to the Clausidiidae. Again the mouthparts were not discussed.

His descriptions of these two species were sufficiently similar for Wilson and Illg (loc. cit.) to suggest an investigation into their possible congeneracy. Accordingly, advantage was taken of a visit to the United States National Museum in September 1958 to pursue this problem (as part of a taxonomic analysis of the Clausidiidae, on which I am currently engaged) Examination of the type material available there of both Wilson's genera indicated that a single species is represented; this is redescribed.

***Pherma curticaudatum*** C. B. Wilson, 1923

*Synonym*.—*Pestifer agilis* C. B. Wilson, 1944: 546-547, pl. 31, figs. 165-171.

*Material examined*.—The syntypes are "three adult females, one of which bore egg strings . . . from the parapodia of an unnamed annelid, dredged from a depth of 645 fms. by the Bureau of Fisheries steamer 'Albatross' off the coast of lower California in April, 1911. These . . . are deposited in . . . the American Museum of Natural History (Cat. No. 4617)." (Wilson, 1923.) Two specimens—one ovigerous but without maxillipeds, the other lacking the cephalosome and one of each of the three pairs of swimming legs—were found in the U.S. National Museum

collections (no. 59354: the label with them also lists the *Albatross* station number as D5685); both were dissected for study. The third is still in the original repository. It was examined without dissection after clearing in methyl salicylate. This specimen lacks only the right maxilliped and caudal rami but unfortunately, in the course of preparation, broke in half.

The other specimens studied were two females, from the skin of an annelid dredged near the Tortugas Islands, Gulf of Mexico, in 380 fathoms, July 18, 1932; USNM no. 79641. Although Wilson (1944) lists one of these as the holotype of *Pestifer agilis*, both were included in the same vial. It is possible that the female which I dissected is the one on which most of Wilson's drawings were based, since it was devoid of one of each pair of the appendages he figured and both maxillipeds. The other was examined as a temporary whole mount in lactic acid; one maxilliped and both ovisacs have been removed during the course of this investigation.

To simplify reference to these specimens, the following abbreviations are used: "Ph. 1," the ovigerous *Pherma* female; "Ph. 2," the mutilated *Pherma* female; "Ph. 3," the *Pherma* female in the American Museum; "Pe. 1," the relatively undamaged *Pestifer* female; and "Pe. 2," the *Pestifer* female which I (and Wilson?) have dissected.

*Female*.—Wilson's figure of the habitus (1923, fig. 1)<sup>1</sup> is better than any which could be attempted with the existing material; it shows very well the delimitation of the first pedigerous segment both from the second and from the cephalosome,<sup>2</sup> the remainder of the metasome swollen and fused into a single mass whose three constituent segments are indicated by constrictions at approximately equidistant intervals along the body, and the abrupt narrowing at the origin of the 3-segmented urosome. Lacking, however, is any clear indication that the first segment of the urosome is set off from the last

<sup>1</sup> All references to figure numbers from C. B. Wilson's papers have here been placed in boldface type.

<sup>2</sup> The latter division, as he mentions in the text, is absent on the ventral side.

metasomal segment; a definite line of thickening does in fact occur at this point. The dorsal boundary between the genital and anal segments is also less well defined than shown in his drawings.

Another fact which he does not mention or indicate in his figures is that the genital segment can be seen in ventral view (Fig. 16) to have an irregular thickened line, running transversely just anterior to the openings of the oviducts, which divides it into an anterior and a posterior part. In the latter of these, two dark areas (which may represent paired seminal receptacles) show up very distinctly even in cleared specimens.

The caudal rami (Fig. 9) are neither "jointed" (Wilson, 1944) nor "destitute of setae" (Wilson, 1923). This confusion has evidently arisen because the middle seta of the three terminal ones on each ramus is enlarged nearly to the diameter of the ramus itself. There is a slight transverse constriction in its proximal portion which probably corresponds to the end of the basal "peg" characteristic of one or two of the terminal caudal setae in less modified copepods. The other two setae at the end of each caudal ramus are slender and, in most of the specimens, lie close to the shaft of the main one, so that it is not easy to determine their exact lengths. There are also two short setae on the outer face of the ramus, both in the distal half, and one dorsally—all slender and inconspicuous.

The considerable difference between the lengths which Wilson gives for the body of *curticaudatum* (4.40 mm) and of *aquilis* (6.24 mm) is not shown by the specimens. It was difficult to make measurements since the only whole animals curved; rough estimates, for which a ruler and dissecting microscope were used, indicate that Ph. 3 was about 4.5 mm long (without caudal rami) and Pe. 1 more than 3.7 mm. Since the metasome and urosome of Pe. 2 are of comparable size to those of Pe. 1, it is probable that Wilson's first figure is the more accurate.

In all the specimens which possessed a cephalosome there is a groove separating the anterior part of the ventral surface from the wide, non-protuberant rostrum (Fig. 10). The "ventral cephalic shield" so delimited partially overhangs (in ventral view) the lateral depressions where the antennules and antennae insert, and its border continues thereafter as a thickened ridge,

terminating eventually at the extreme posterior corner of each maxilla (Fig. 11).

No postoral protuberance, between the maxillipeds and first pair of legs, could be distinguished.

The antennules are slender structures with six podomeres (Fig. 1). No evidence could be found for the division of the basal podomere into the two short ones shown by Wilson (1944, pl. 31, fig. 167)—no doubt the reason why he termed this appendage 7-segmented—nor for his claim (loc. cit., p. 547) that "the only setae are terminal on the end segment." The pattern appeared to vary among the specimens; its most complete form (Ph. 1, left) was—proximal to distal podomeres: 2, 6, 3, 2, 2 plus 1 aesthete, and 7 plus 1 aesthete.

The antennae (Fig. 2) may have three or four podomeres, since the division between the third and fourth—a line at best—is sometimes completely absent. The terminal armature accords well with what I consider to be basic among poecilostomes: a row of curved setae (here three instead of the more usual four) between, on the one side, two more slender setae, which are located in a depression behind the tip of the appendage toward its outer face, and one more distally placed on the other; but that on the third podomere is reduced to a single seta, usually accompanied by three small elements. Nothing could be found on the first two podomeres. It is possible that Wilson (1944) partially confused the antennae with the maxillipeds since, in his generic diagnosis of *Pestifer* (p. 546), he speaks of them as "prehensile" and figures (pl. 31, fig. 168) what is obviously the other appendage under the title "second antenna".

The mouth is placed more anteriorly than is usual in copepods (under the median part of the labrum in Fig. 11). In ventral view the labrum forms a shallow, wide area with thickened exoskeleton; its posterior edge is broken by three projections. The middle one of these has heavily sclerotized sides but a thin ventral surface, so that it generally appears medially incised rather than, as is in fact the case, posteriorly acuminate especially if viewed from behind instead of ventrally. In the latter aspect it may be seen to be divided for most of its length by a line parallel to the sides. This medial structure appears to correspond to the labral area of more typical poecilostomes, while the two lateral "hooks," which extend backward nearly

to the maxillae, are a distinctive feature of *curticaudatum*. Under each is a local modification of the ventral exoskeleton (its outline shown dashed on the right side of Fig. 11) which fits into the depression in the anterior surface of the mandible. A fleshy, protuberant structure arising just posterior to the angle of the maxillae (and presumably preventing excess posterior movement in these) is believed to represent the labium. The heavily sclerotized borders around the bases of the maxillae fuse medially to delimit the labium from an anterior, triangular area which continues uninterrupted to the mouth. In it, at the level of the median maxillar insertions, is a longitudinal ridge bearing, like the surrounding parts of this surface, a few tiny spinules. Nothing resembling characteristic paragnaths could be found but two small flaps clothed in short cilia occur—one on either side of the midline—under the inner lobes of the maxillules (and thus hidden by them in Fig. 11).

The mandible is oriented with its flat surface almost parallel to the plane of the mouth region, the main shaft extending forward at an angle of about 45° to the transverse and the tip curving backward (Fig. 11). Terminally (Figs. 3, 4) it bears a stout curved spine, with a toothed flange on its ventral side, and a short fimbriate lamella, both articulating with the body of the appendage and pointing somewhat posteriorly. As is typical in clausiids, the appendage is small and, in an undissected specimen, very difficult to distinguish under the labrum and inner lobe of the maxillules.

The maxillules (Fig. 5) are unimerous but bilobed: the outer, bearing three setae, is thinly sclerotized and protrudes in a transversely posteroventral direction from the lower side of the appendage, while the two setae of the inner lobe—one covering the other in a ventral view—extend toward the mouth. One or more of these setae on both lobes sometimes could not be discerned: this is presumed due to variation, to the hazards of dissection, or to difficulties in observation.

The maxillae (Fig. 6) insert over a considerable area of the cephalosome. They appear to

resemble closely the same pair of appendages in *Clausia* (Giesbrecht, 1893), and, like these, their segmentation is difficult to distinguish. It seems probable that each has two podomeres, the basal being greatly expanded, the distal inserted eccentrically upon it and bearing a thickly spinulose dorsal lobe. Neither podomere is armed in the conventional fashion, but it is possible that the dorsal lobe, which appears to articulate at its base, represents a modification of the terminal armature. One may speculate that, by grinding the tips of this pair of appendages together, the animal could triturate the relatively soft skin of its host and feed on the resultant debris.

The maxillipeds form the main prehensile apparatus. Each is strongly developed and tetramerous (Fig. 7). The first two podomeres are somewhat inflated and the fourth produced into a strong, tapering, hooklike structure. Patches of fine spinules on the inner surface of the first and second podomeres represent the only ornamentation. The armature consists of a short seta on the inner surface of the fourth podomere and a small element near the inner curvature of the hook.

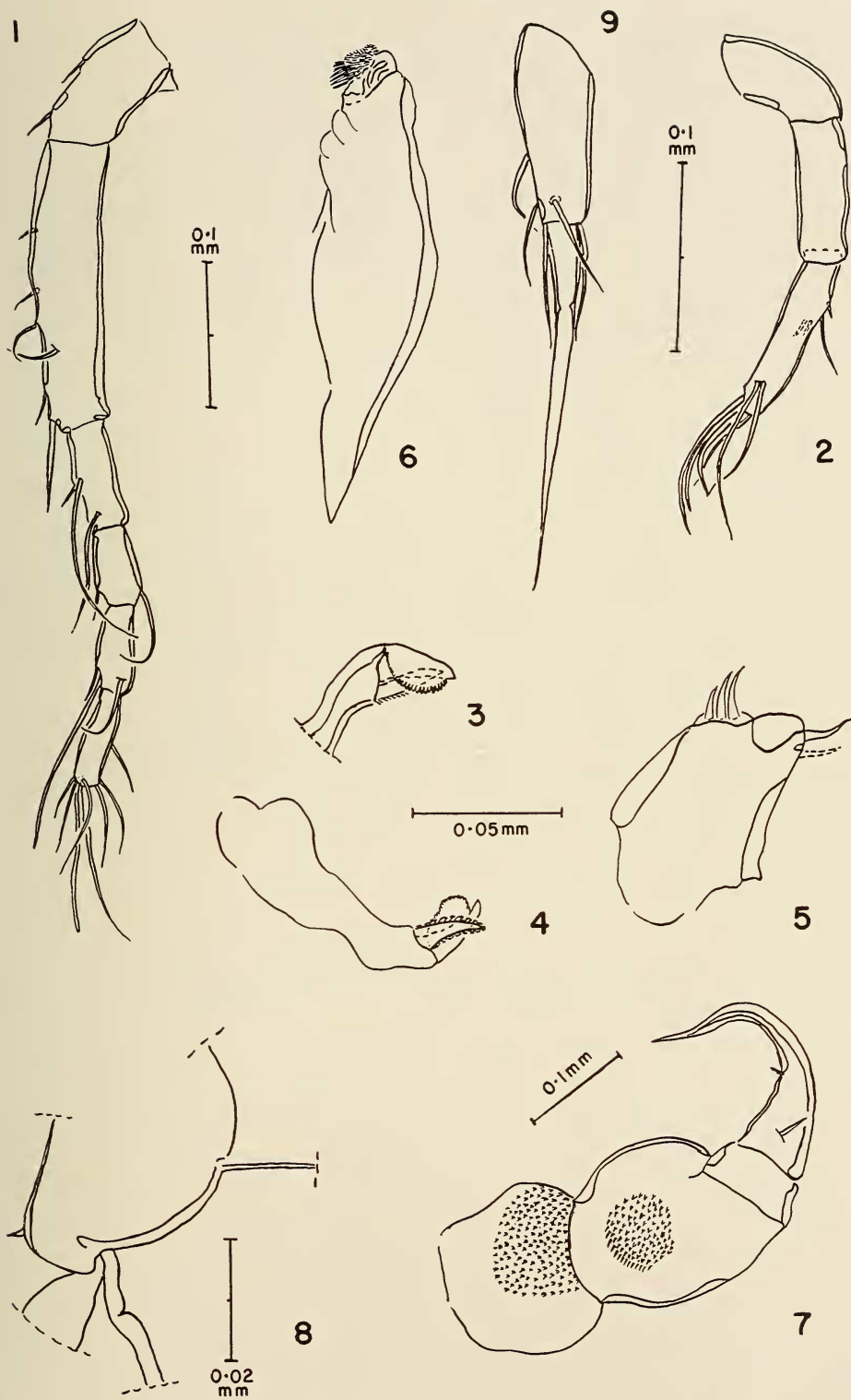
Despite Wilson's statement (1944: 546, 547), there are only three pairs of legs on the metasome, no trace being found of the fourth. Each is small and is borne just anterior to the middle of its respective somite. The legs are biramous, the two rami and the protopodite having two podomeres respectively, although the division between those of the endopodite is sometimes very difficult to distinguish. The armature is somewhat irregular: the basic pattern appears to be:

	<i>prot.</i>		<i>endp.</i>		<i>ezop.</i>	
	1	2	1	2	1	2
Leg 1	--	I 1.	1 -	6 -	- I.	4 IV.
Leg 2	--	- 1.	1 -	5 -	- I.	4 III.
Leg 3	--	- 1.	1 -	4 -	- I.	3 III.

but, as shown in Figs. 12-14, this may vary even between the legs of a single pair. The main differences occur in the second legs, where the last podomere of the endopod may have four (Ph. 2, left leg), five (Ph. 1, L; Ph. 3, both legs; Pe. 1, B; Pe. 2, L), or six setae (Ph. 1, R) and that

FIGS. 1-9.—*Pherma curticaudatum* Wilson, female: 1, Left antennule, ventral; 2, left antenna, dorsal; 3, tip of left mandible, ventral; 4, left mandible, dorsal; 5, left maxillule, dorsal; 6, left maxilla, dorsal; 7, right maxilliped, medial aspect; 8, right sixth leg and adjacent structures, ventral; 9, left caudal ramus, dorsal. (Figs. 1, 2, 4-6, 9, and 12-16 are of Ph.1; 10 of Ph.3; 11 of Pe.1; and 3, 7, and 8 of Pe. 2. A camera lucida was used for Figs. 10 and 11; the others were drawn with a carbon-arc type of projection apparatus. Scales refer to the figure (or figures) nearest them, and were made from a stage micrometer.)





Figs. 1-9.—(See opposite page for legend).

of the exopod three (Ph. 1, R; Ph. 2, L) or four (Ph. 1, L; Ph. 3, B; Pe. 1, L; Pe. 2, R). It is interesting to note that on the exopod spines of all the legs distal setules—so characteristic a feature in a number of poecilostome genera that they may represent a primitive tendency in this group—are present (Fig. 15).

The fifth pair of legs is completely lacking, but sixth legs are considered to be represented in some of the specimens by a small stout seta just anterior to the origin of the ovisacs on either side of the genital segment (Fig. 8).

*Male*.—No male was present in either of the collections, and I know of no account in the literature of a copepod which could be so assigned. This is unfortunate since a knowledge of the morphology of males from each locality might do much to clear up the taxonomic dilemma posed in the next section.

*Remarks*.—There seems little doubt that the genera *Pestifer* and *Pherma* are synonymous, but I should like to consider briefly the reasons why I have identified *Pe. agilis* with *Ph. curticaudatum*. As noted in the description, the available specimens exhibit differences in the armature of the antennules, antennae, maxillules, and metasomal legs, in the segmentation of the antennae and legs, and in the shape of the ovisacs. None of the first six characters is apparently consistent within the specimens of one species, and variation may occur even between the appendages on opposite sides of the same animal. In some of the cases where changes in armature are involved it has been possible to infer accidental loss of certain setae.

The last of the differences (shape of the ovisacs) is evident from a comparison of Wilson's (1923) fig. 1 and (1944) pl. 31, fig. 165, and borne out by my examination of his specimens. Although there is usually considerable variation in the form of the ovisacs even in a single population of a particular copepod, the mean may prove valid as one of the complex of characters which distinguishes that species. But here only one representative in each collection possessed intact ovisacs. I should not like to diagnose two

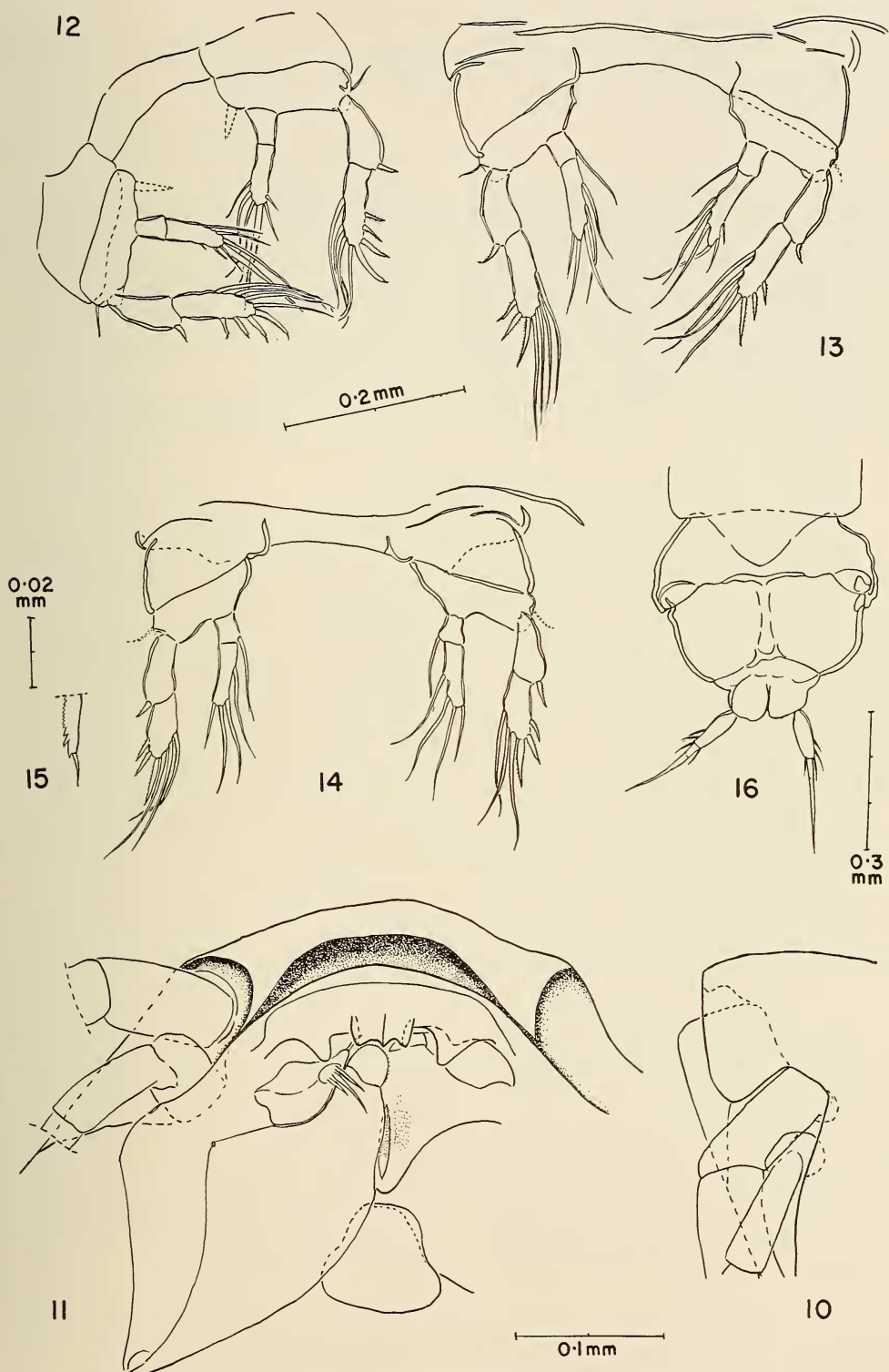
species on such a basis, particularly since the specimens are from different geographical areas and might thus be expected to show some slight variation.

Comparative zoogeography, however, suggests that the two collections are more likely to represent different species than to compromise a single one and, although this argument is purely inferential, it seems suitable to consider it here. According to Ekman (1953), archibenthal animals (both *curticaudatum* and *agilis* fall into this category) show only limited distribution patterns. If one assumes that the depth at which these copepods were found represents their lower limit, then there still exists evidence that the tropical shelf fauna on either side of Central America possesses many more pairs of closely related species than forms with an ampho-American range, and that the latter are all very ancient. (Paleontological information about copepods is almost nonexistent.) Even if these copepods extend into the abyssal region, a continuous distribution is not very probable. Nor do their hosts provide more assistance on this topic since neither was identified further than to group.

The position is, then, that on morphological grounds the available material appears to represent a single species whose phenotypic variation is not in excess of that to be expected in an animal modified for a strictly associated existence, nor does it provide a basis for specific separation. On the other hand, the locations from which the specimens were collected might lead one to expect the presence of two similar species. The number of specimens is too small to decide conclusively between these alternatives. But, since copepod taxonomy is still dependent almost entirely on morphological criteria, the former has seemed preferable. I shall thus leave to some future worker, with more material at his disposal, the onus of proving that speciation or subspeciation has occurred in *Pherma curticaudatum* (in which case Wilson's name *agilis* may be revived for the West Indian form).

It seems possible now to refer *Pherma* to the

FIGS. 10-16.—*Pherma curticaudatum* Wilson, female: 10, View of the anterior part of the cephalosome from the left side, showing groove between rostrum and mouth area, and insertions of the antennule and antenna; 11, ventral view of the anterior part of the cephalosome: the mandible and framework around the base of the maxilla are shown on the right side of the figure; the bases of the antennule and antenna, the maxillule and maxilla on the left; 12, first pair of legs and coxal plate, ventral; 13, second pair of legs and coxal plate, ventral; 14, third pair of legs and coxal plate, ventral; 15, detail of tip of terminal exopod spine on leg 3; 16, part of urosome, ventral. (In Figs. 12-14, certain elements of the armature whose absence in the specimen from which they were drawn is presumed to be accidental have been indicated by dashed outlines. Figs. 10 and 11 are somewhat diagrammatic.)



FIGS. 10-16.—(See opposite page for legend).

Clausiidæ, a step which makes some changes necessary in the present definition of that family (M. S. Wilson and Illg, 1955). Treatment of this will be deferred to a later paper.

This study was begun at the U.S. National Museum and completed in the Department of Biology, Boston University; it has been supported in part by a research grant to Dr. Paul Illg from the State of Washington Initiative 171 Fund for Research in Biology and Medicine. My thanks are due to the authorities of the institutions mentioned for the use of their facilities, and to Dr. Libbie Hyman and Dr. Thomas Bowman for their assistance in obtaining type ma-

terial on loan. Dr. Illg and Dr. Arthur Humes have been kind enough to read and criticize the manuscript.

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### DR. FRIEDMANN AWARDED ELIOT MEDAL

DR. HERBERT FRIEDMANN, acting head curator, department of zoology, U. S. National Museum, Smithsonian Institution, has recently received the Daniel Giraud Elliot Medal of the National Academy of Sciences for his book *The honey-guides*. The Elliot Medal is awarded for the most meritorious work in zoology or paleontology published each year.

Dr. Friedmann's studies of the honey-guide, issued by the Smithsonian, clarified several puzzling problems about these birds. Prior to this work it was thought that the birds fed chiefly on the honey and bee larvae in wild bees' nests, but being unable to open such nests by themselves, the birds led or guided humans to the hives (hence the name honey-guide), and then after the men had taken their fill, they came back to feed on the remnants left strewn about. Since the only use to the bird of the guiding habit depended upon the cooperation of a totally independent creature, man, the habit could not have had any value until it was perfected by both participants, and in such a way as to help the birds. It was found that the African natives deliberately substituted themselves for the original "partner" of the bird, the ratel or honey-badger. The guiding behavior, which appears so pur-

posive, is merely an excitement reaction of the bird when it meets with a potential foraging associate, and which calms down when it sees or hears bees. Since this usually happens near a bees' nest, the effect is that the follower is usually led to a hive. Many observations show that the behavior is purely instinctive and involves no "planning" or preknowledge by the bird. It was also found that the birds' interest in the hives was in the wax of the comb not in the honey or bee larvae. Studies showed that the birds depend on was-splitting microbes in their digestive tracts to make the wax digestible.

Born in New York City April 22, 1900, Dr. Friedmann took his undergraduate training at City College in New York and received his Ph.D. in ornithology from Cornell University in 1923. He was a National Research Council fellow at Harvard University from 1923 to 1926, an instructor at Brown University, 1926-27, and at Amherst College, 1927-29. He has been a curator in the Division of Birds at the U. S. National Museum since 1929. He is the author of many ornithological works, including *The parasitic cuckoos of Africa*, Monograph No. 1 of the Washington Academy of Sciences.